

Technology Summary

NASA IVHM Technology Experiment for X-vehicles (NITEX)

The purpose of the NASA IVHM Technology Experiment for X-vehicles (NITEX) is to advance the development of selected IVHM technologies in a flight environment and to demonstrate the potential for reusable launch vehicle ground processing savings. The technologies to be developed and demonstrated include system-level and detailed diagnostics for real-time fault detection and isolation, prognostics for fault prediction, automated maintenance planning based on diagnostic and prognostic results, and a microelectronics hardware platform. Complete flight IVHM consists of advanced sensors, distributed data acquisition, data processing that includes model-based diagnostics, prognostics and vehicle autonomy for control or suggested action, and advanced data storage. Complete ground IVHM consists of evolved control room architectures, advanced applications including automated maintenance planning and automated ground support equipment. This experiment will advance the development of a subset of complete IVHM.

The experiment consists of an on-board Real-time Flight Unit (RFU) and a ground-based Ground Processing Unit (GPU). Within the RFU resides the real-time operating system, diagnostic and prognostic models, diagnostic engine and sensor monitoring software. The RFU has been designed as a lightweight low power microelectronics data acquisition and processing platform with the capability to link to a vehicle data bus for passive monitoring of the vehicle command and data streams. Sensor events relevant to the diagnostic models are recognized by the monitoring software and reported to the diagnostic engine, which uses the models to continually track expected system behavior, identify discrepant observations and diagnose the cause of the off-nominal condition. The experiment will be activated at a pre-determined mission elapsed time, and begin processing and internally recording system health data throughout all supported mission phases. The flight box output may be downlinked to the ground monitoring station, using the vehicle telemetry link, for real-time display of vehicle subsystem performance, and may also be dumped post-landing for analysis. The information displayed will include any fault isolations, any fault predictions, any generated recommended real-time recovery actions and the resulting ground maintenance requirements including identification of line replaceable unit (LRU) changeouts.

The experiment was originally slated to fly on the X-34 Reusable Launch Vehicle. As of March 2001, the X-34 program has been cancelled. A demonstration of existing X-34 IVHM flight and ground software for 16 mission scenarios will be held in July. This demonstration establishes a baseline for the NITEX software with credible success at diagnosing a subset of X-34 vehicle failures. The diagnostic models focus on the health of the X-34 main propulsion system. With the development of suitable diagnostic models for the target, the NITEX system may be deployed on virtually any accommodating target. Alternate vehicle platforms suitable for deployment of NITEX technology are being actively sought.

Goals

Present and promote benefits provided by technologies

- *More efficient maintenance and turnaround processing* - The capability of the vehicle to report what propulsion system components need attention and which components are operating nominally will lead to more efficient maintenance and turnaround processing
- *IVHM cost/benefit metrics* - Savings quantified through cost/benefit analysis of IVHM impact on maintenance plan.
- *Enhanced safety and reliability* through better real-time visibility into system health. Demonstration of real-time diagnostic is also the first step in providing enhanced safety through autonomous control.

Verify technologies in flight

- Numerical analysis algorithms to isolate and predict failures (detailed diagnostics) and identify degraded components.
 - System-level modeling technique to detect and isolate failures.
 - Intelligent executive to evaluate impact of failures and *record* recommended course of action for post-flight evaluation.
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Demonstrate capabilities of the partners

- Each team member brings unique approaches, capabilities, experience and expertise to the project

Influence planning for IVHM in future vehicles

- The capabilities and benefits of IVHM on a vehicle where it has been designed in rather than added on will be greatly improved
- Validated technology that is ready for incorporation into the baseline IVHM systems of future (and current) launch vehicles.



